MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 3, 2016/2017

EME3236 – HEATING, VENTILATION AND AIR CONDITIONING SYSTEMS

(ME)

01 JUNE 2017
9.00 a.m - 11.00 a.m.
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This Question paper consists of 12 pages with 4 Questions only.

2. Attempt **ALL** questions. All questions carry equal marks and the distribution of the marks for each question is given.

3. Please write all your answers in the Answer Booklet provided.

Question 1

(a) Interpret the following terms as applied to HVAC System:

i. One TR **[3 marks]**
ii. COP **[3 marks]**
iii. SHR **[3 marks]**

(b) Hot water at 70°C is to be produced by using Furness and supplied to the desire reservoir at distance of 150 m. Horizontal pipe with a diameter of 25 mm and a friction factor of 0.029 is used to carry the hot water. The hot water average velocity is 0.63 m/s. Determine:

i. The pressure drop through this pipe **[5 marks]**
ii. The pumping power requirement to pump the hot water through this pipe. **[3 marks]**

Take the density of hot water at 70 °C as 1000 kg/m^3.

(c) On a certain day the weather prediction states that the dry bulb temperature is 37 °C, while the relative humidity is 50% and the barometric pressure is 101.325 kPa. Find the humidity ratio, dew point temperature and enthalpy of moist air on this day. **[8 marks]**

Continued ...

Question 2

(a) Write a brief note on the following terms:

i. Internal load **[5 marks]**

ii. External load **[4 marks]**

iii. Variable air volume system (VAV). **[3 marks]**

(b) Ducting configuration of an industrial system is shown in the Figure **Q2(b)**. Determine the rectangular size for each section of the system which depth is maintained at 14 in throughout using equal friction method. Air is flowing at the rate indicated. (Can refer to some attached table at appendix).

Notes: Duct calculator can be used as well.

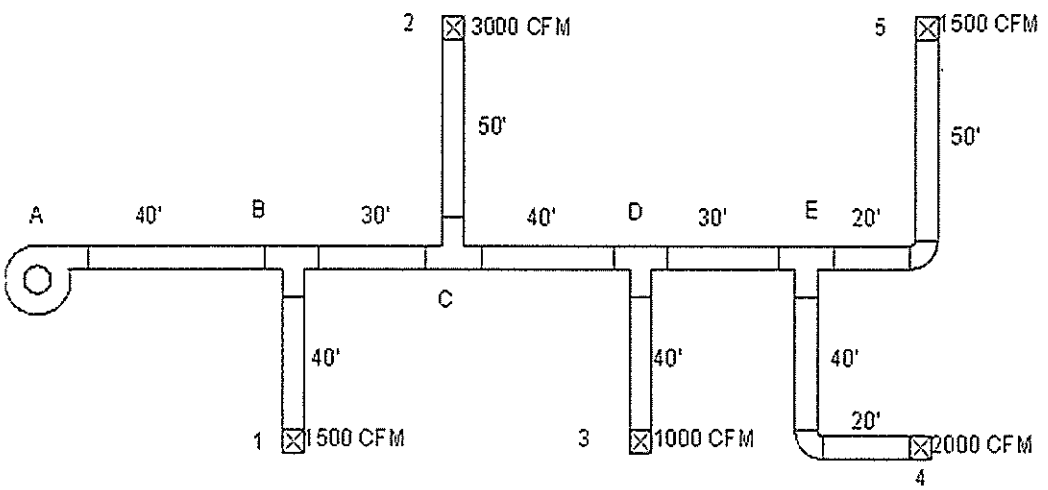


Figure Q2(b)

[13 marks]

Continued ...

Question 3

(a) Define the following:

i. Psychrometry **[2 marks]**

ii. By Bass Factor **[2 marks]**

iii. Cooling Tower **[2 marks]**

(b) A work place area of 100 m^2, is a part of huge insulated vacancy building, which is high insulated, thus the external heat gain is almost ignored. The work place is occupied by 10 individuals. from 8:00 a.m. to 5:00 p.m. The heat gain due to equipment's such as computers, photocopiers, fax machines, is 9.4 W/m^2 and due to lighting is 12.4 W/m^2 of recessed, unvented fluorescent fixtures on from 8:00 a.m. to 5:00 p.m. Assume the sensible heat from occupants composed of 60 % radiative and 40% convective. The sensible heat from equipment composed 20% radiative and 80% convective The sensible heat from lighting 30% enters the space directly, and the rest composed 77 % radiative and 23 % convective.

i. Estimate the radiative and convective portions, for the sensible heat gain to the space,

[14 marks]

ii. Compute the total sensible and, latent heat gains at 4: 00 p.m. for the space,

[3 marks]

iii. Calculate the cooling load for this office due the internal heat gain

[2 marks]

Continued ...

Question 4

(a) Define the following

i.Fan Performance **[2 marks]**

ii. Thermal Comfort **[2 marks]**

iii. Latent heat **[2 marks]**

(b) A sport hall is designed to suit 300 audience and to be maintained at 25 °C and 55% RH. The ventilation requirement per person is 6 litre/s. The outside air-conditions are 35 °C and 70% RH. The infiltration rate through the exam hall windows and doors is approximated to 0.43 air change per hour (ACH). If the hall volume is 1000 m^3, estimate:

i. The mass flow rate of the ventilated air in kg/min, **[5 marks]**

ii. The sensible and latent heat transfer rates due to ventilation, **[6 marks]**

iii. The mass flow rate of the infiltrated air in kg/min, **[2 marks]**

iv. The sensible and latent heat transfer rates due to infiltration, **[4 marks]**

v. The total cooling load on the air conditioning system due to ventilation and infiltration in kW. **[2 marks]**

End of pages

Appendix

Dracy equation:

$$H = hL = f * (L/D) * v2 / 2g$$

where f is the friction factor,
L is the length of the duct/pipe,
V is the average velocity of the fluid, and
D is the hydraulic diameter of the duct/pipe.

$w = 0.622 \times Pv/(Pt-Pv)$

$h = 1.005t+w(2501+1.88t)$

Sensible heat due to ventilation/investigation

$$Q_h = m_a(h_B - h_O) = m_a c_{pm}(T_B - T_O)$$

$$Q_{l,inf} = \dot{m}_o h_{fg}(W_o - W_i) = \dot{V}_o \rho_o h_{fg}(W_o - W_i)$$

Where :
$C_{pm} = 1.005$ Kj/kg * K
$h_{fg} = 2501$ kJ/kg

$\dot{m}a\ v = \rho * \dot{V}$

Ideal gas equation : $Pv = RT$

$Q_H - Q_L = W$

$Q = \dot{m} \times Cp \times (To - T\ in)$

1TR= 12.000 BTU/h = 3.5167 kW

EER = COP * 3.412

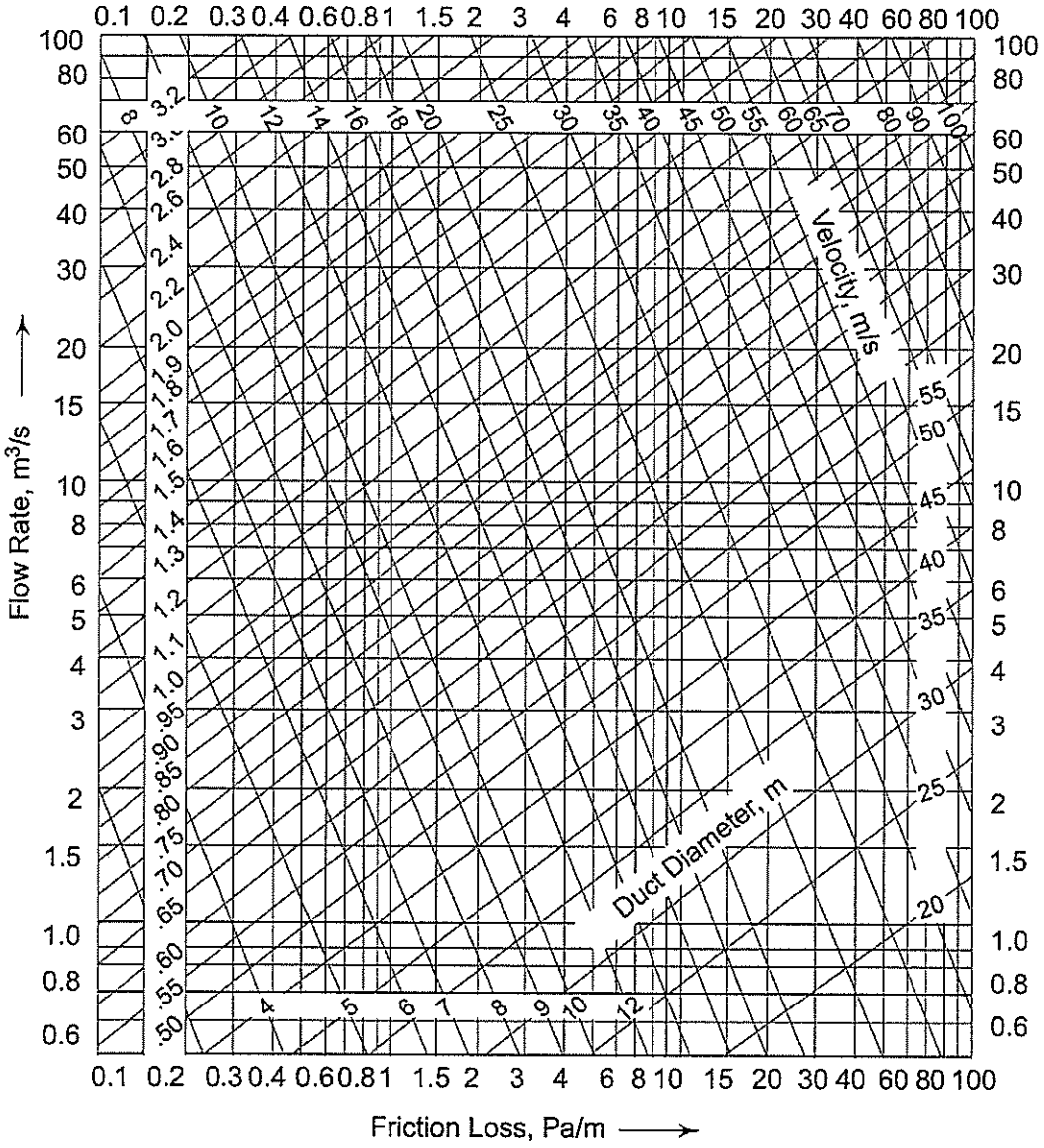
Table 8-2 Rates of Heat Gain from Occupants of Conditioned Spaces[a]

		Total Heat Adults, Male		Total Heat Adjusted[b]		Sensible Heat		Latent Heat	
Degree of Activity	Typical Application	Btu/hr	W	Btu/hr	W	Btu/hr	W	Btu/hr	W
Seated at theater	Theater—matinee	390	114	330	97	225	66	105	31
Seated at theater	Theater—evening	390	114	350	103	245	72	105	31
Seated, very light work	Offices, hotels, apartments	450	132	400	117	245	72	155	45
Moderately active office work	Offices, hotels, apartments	475	139	450	132	250	73	200	59
Standing, light work; walking	Department store, retail store	550	162	450	132	250	73	200	59
Walking; standing	Drugstore, bank	550	162	500	146	250	73	250	73
Sedentary work[c]	Restaurant	490	144	550	162	275	81	275	81
Light bench work	Factory	800	235	750	220	275	81	475	139
Moderate dancing	Dance hall	900	264	850	249	305	89	545	160
Walking 3 mph; light machine work	Factory	1000	293	1000	293	375	110	625	183
Bowling[d]	Bowling alley	1500	440	1450	425	580	170	870	255
Heavy work	Factory	1500	440	1450	425	580	170	870	255
Heavy machine work; lifting	Factory	1600	469	1600	469	635	186	965	283
Athletics	Gymnasium	2000	586	1800	528	710	208	1090	320

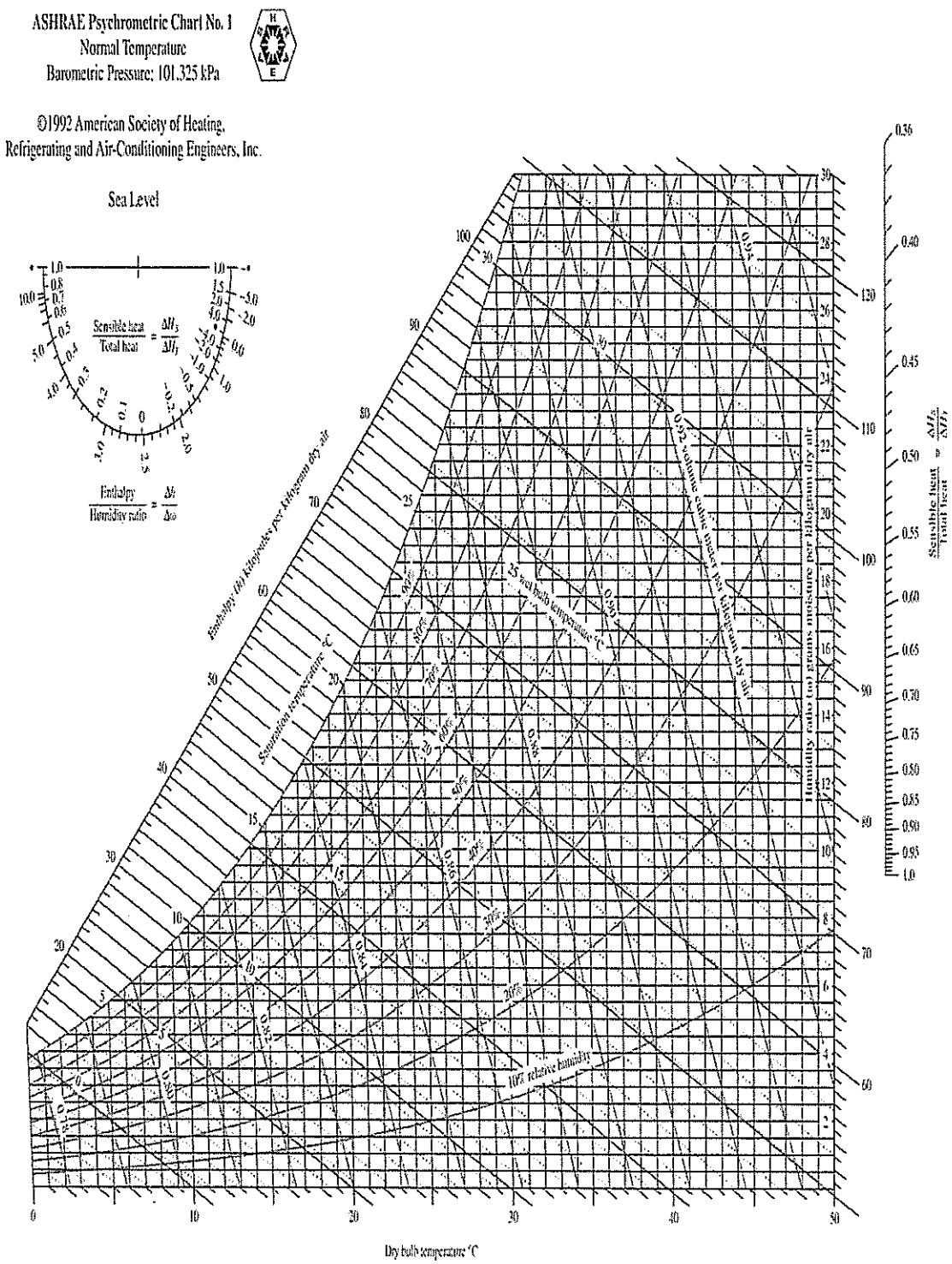
TABLE 8.11 SUGGESTED VELOCITIES IN LOW VELOCITY AIR CONDITIONING SYSTEMS

	Recommended Velocities, FPM			Maximum Velocities, FPM		
Designation	Residences	Schools, Theaters, Public Buildings	Industrial Buildings	Residences	Schools, Theaters, Public Buildings	Industrial Buildings
Outside air intakes[a]	500	500	500	800	900	1200
Filters[a]	250	300	350	300	350	350
Heating coils[a]	450	500	600	500	600	700
Air washers	500	500	500	500	500	500
Suction connections	700	800	1000	900	1000	1400
Fan outlets	1000–1600	1300–2000	1600–2400	1700	1500–2200	1700–2800
Main ducts	700–900	1000–1300	1200–1800	800–1200	1100–1600	1300–2200
Branch ducts	600	600–900	800–1000	700–1000	800–1300	1000–1800
Branch risers	500	600–700	800	650–800	800–1200	1000–1600

Friction chart in SI system



Psychrometric chart



Saturated water Temperature table

		Specific volume m³/kg		Internal energy kJ/kg			Enthalpy kJ/kg			Entropy kJ/kg-K		
Temp. T°C	Sat. Press. P_{sat} kPa	Sat. Liquid v_f	Sat. Vapor v_g	Sat. Liquid u_f	Evap. u_{fg}	Sat. Vapor u_g	Sat. Liquid h_f	Evap. h_{fg}	Sat. Vapor h_g	Sat. Liquid s_f	Evap. s_{fg}	Sat. Vapor s_g
0.01	0.6117	0.001000	206.00	0.000	2374.9	2374.9	0.001	2500.9	2500.9	0.0000	9.1556	9.1556
5	0.8725	0.001000	147.03	21.019	2360.8	2381.8	21.020	2489.1	2510.1	0.0763	8.9487	9.0249
10	1.2281	0.001000	106.32	42.020	2346.6	2388.7	42.022	2477.2	2519.2	0.1511	8.7488	8.8999
15	1.7057	0.001001	77.885	62.980	2332.5	2395.5	62.982	2465.4	2528.3	0.2245	8.5559	8.7803
20	2.3392	0.001002	57.762	83.913	2318.4	2402.3	83.915	2453.5	2537.4	0.2965	8.3696	8.6661
25	3.1698	0.001003	43.340	104.83	2304.3	2409.1	104.83	2441.7	2546.5	0.3672	8.1895	8.5567
30	4.2469	0.001004	32.879	125.73	2290.2	2415.9	125.74	2429.8	2555.6	0.4368	8.0152	8.4520
35	5.6291	0.001006	25.205	146.63	2276.0	2422.7	146.64	2417.9	2564.6	0.5051	7.8466	8.3517
40	7.3851	0.001008	19.515	167.53	2261.9	2429.4	167.53	2406.0	2573.5	0.5724	7.6832	8.2556
45	9.5953	0.001010	15.251	188.43	2247.7	2436.1	188.44	2394.0	2582.4	0.6386	7.5247	8.1633
50	12.352	0.001012	12.026	209.33	2233.4	2442.7	209.34	2382.0	2591.3	0.7038	7.3710	8.0748
55	15.763	0.001015	9.5639	230.24	2219.1	2449.3	230.26	2369.8	2600.1	0.7680	7.2218	7.9898
60	19.947	0.001017	7.6670	251.16	2204.7	2455.9	251.18	2357.7	2608.8	0.8313	7.0769	7.9082
65	25.043	0.001020	6.1935	272.09	2190.3	2462.4	272.12	2345.4	2617.5	0.8937	6.9360	7.8296
70	31.202	0.001023	5.0396	293.04	2175.8	2468.9	293.07	2333.0	2626.1	0.9551	6.7989	7.7540
75	38.597	0.001026	4.1291	313.99	2161.3	2475.3	314.03	2320.6	2634.6	1.0158	6.6655	7.6812
80	47.416	0.001029	3.4053	334.97	2146.6	2481.6	335.02	2308.0	2643.0	1.0756	6.5355	7.6111
85	57.868	0.001032	2.8261	355.96	2131.9	2487.8	356.02	2295.3	2651.4	1.1346	6.4089	7.5435
90	70.183	0.001036	2.3593	376.97	2117.0	2494.0	377.04	2282.5	2659.6	1.1929	6.2853	7.4782
95	84.609	0.001040	1.9808	398.00	2102.0	2500.1	398.09	2269.6	2667.6	1.2504	6.1647	7.4151
100	101.42	0.001043	1.6720	419.06	2087.0	2506.0	419.17	2256.4	2675.6	1.3072	6.0470	7.3542
105	120.90	0.001047	1.4186	440.15	2071.8	2511.9	440.28	2243.1	2683.4	1.3634	5.9319	7.2952
110	143.38	0.001052	1.2094	461.27	2056.4	2517.7	461.42	2229.7	2691.1	1.4188	5.8193	7.2382
115	169.18	0.001056	1.0360	482.42	2040.9	2523.3	482.59	2216.0	2698.6	1.4737	5.7092	7.1829
120	198.67	0.001060	0.89133	503.60	2025.3	2528.9	503.81	2202.1	2706.0	1.5279	5.6013	7.1292

Friction chart